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(71) Applicant *(for all designated States except US)*: ORGANIC GOLD PTY. LIMITED [AU/AU]; 160 Sailors Bay Road, Northbridge, NSW 2063 (AU).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: KELLY, Graham, Edmund [AU/AU]; 112 Kameruka Road, Northbridge, NSW 2063 (AU).

(74) Agent: SPRUSON & FERGUSON; G.P.O. Box 3898, Sydney, NSW 2001 (AU).

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(57) Abstract

There is provided a plant fertiliser comprising at least one fertiliser component and a plant growth enhancing amount of at least one carotenoid. The fertiliser component may be selected from the group consisting of a known inorganic fertiliser and a known organic fertiliser. Alternatively, the fertiliser component may be altered protein containing vegetable matter, as defined in the specification herewith, having a plant growth enhancing amount of at least one carotenoid. There is further provided a process for preparing such a fertiliser, a fertiliser composition and a fertiliser mixture comprising such a fertiliser, and a method of fertilising a plant using such a fertiliser.

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FERTILISER

TECHNICAL FIELD

This invention relates to a fertiliser, a fertiliser composition, a fertiliser mixture, a process of preparing a fertiliser, a process of preparing a fertiliser composition and a fertiliser mixture, and a method of fertilising a plant.

BACKGROUND ART

It is well known that 16 chemical elements are essential for plant growth. Three of these - carbon, hydrogen and oxygen - are obtained from carbon dioxide and oxygen in the air and from water. Thirteen others are required to be present in the soil either in relatively large amounts ("major elements") or relatively small amounts ("trace elements"). In the natural cycle of plant life, the 13 essential elements are returned to the soil by decaying plant matter, providing a long-term equilibrium of those elements in both the soil and the growing plants. By cropping plants, however, as in agriculture or in the home garden situation, this natural equilibrium is disturbed. By reducing the amount of decaying plant material, and hence the level of essential elements being returned to the soil, the continued removal of part of the plant (e.g. cropping, grazing, harvesting etc) leads to a net loss over time in the level of some or all of those elements in soil. Those elements, therefore, need to be artificially replaced by the addition of fertilisers in order to maintain healthy plant growth. Additionally, soils may be deficient in certain elements as a result of particular characteristics of the soil, with the result that plants growing on that soil may show signs of ill-health due to particular nutrient deficiencies.

Traditionally, there are two principal forms of fertilisers - inorganic and organic. Inorganic fertilisers are inorganic chemicals comprising the major elements (nitrogen, phosphorus, potassium, calcium, magnesium, sulphur) and trace elements (copper, zinc, boron, molybdenum, iron, manganese, chlorine). Inorganic chemicals may be naturally-occurring (e.g. rock phosphate) or synthetically produced. Inorganic fertilisers may be composed of single or multiple elements.

The term "organic material" is defined as material composed of matter of plant or animal origin, i.e. produced as a result of natural biological processes. Such material is typically composed of protein, carbohydrate, fats, fibrous material, and mineral elements, although there is considerable variation between organic materials in the ratio of these various constituents. Typical organic fertilisers are those derived from animal offal (blood, bone, meat meal) or animal excreta (manure), or decaying vegetable matter (compost, humus, peat moss).

Over the past 40-50 years, inorganic fertilisers have predominated in both agriculture and horticulture. This is largely because their comparatively lesser bulk offers a significant practical advantage in terms of fertiliser application. Also, inorganic

fertilisers are comparatively cheaper in terms of unit cost of a particular element, plus they offer the ability to selectively mix elements to meet special requirements of a particular soil type or plant need. Further, inorganic fertilisers offer the advantage that the inorganic chemicals are in a form which is readily and immediately available to the plant, resulting in a rapid response by the plant following absorption of the element either from the soil or through the leaves. The elements (particularly nitrogen and phosphorus) in organic matter generally are bound in a complex molecular structure which needs to be broken down in the soil by micro-organisms. It is only after this delayed period of decomposition that the elements become available to the plant.

However, inorganic fertilisers do have three disadvantages compared to organic fertilisers. First, the free form of the chemicals in inorganic fertilisers means that the elements are highly susceptible to leaching from the soil following rain; organic matter, containing elements bound within a complex molecular structure, is much more resistant in this respect. Second, inorganic fertilisers do not provide substrate such as carbohydrate to stimulate the growth of soil micro-organisms, a factor which is widely accepted as being an important ingredient for maintaining the normal health of soil and in the production of essential growth factors for plants. Third, the fibrous matter in organic material provides the basis of forming the "tilth" of soil, which refers to the crumble effect of soil which is necessary for aeration and water retention in the soil, prevention of compaction of the soil, and assistance in root penetration.

A compromise situation is a mixture of inorganic and organic elements to produce a fertiliser. This combines the advantages of both fertiliser types, viz. (i) a proportion of elements in an organic form to provide sustained release of certain elements, (ii) the availability of organic carbohydrate to stimulate the activity of soil micro-organisms, and (iii) the ready availability of inorganic elements to provide immediate benefit to plants. Moreover, the process of mixing permits the creation of a fertiliser which is well-balanced in terms of plant nutrients, or is made to meet a specific need (such as a specific soil deficiency).

Mixed inorganic/organic fertilisers may either be in a dry or liquid form. The liquid form, however, requires an additional manufacturing step in that the organic material has to be solubilised. This is to ensure that the organic matter is readily dispersible in water and is sufficiently small to pass through small diameter apertures in watering apparatus. Compared to the dry form, the liquid form offers a number of technical advantages including (i) ease of application, whereby the material, being soluble or dispersible in water, can be applied through a variety of watering processes, (ii) facilitation of penetration of the fertiliser into the soil or direct absorption into the plant via the leaves, and (iii) a quicker availability of organic nitrogen to the plants as a result of the hydrolysis of the organic protein in order to increase its solubilisation in water.

Organic material typically used in making fertilisers is derived from proteinaceous material either from animal material (such as flesh, feathers, blood, manure etc) or from vegetable material (such as kelp, humus etc). Each of these materials are in relatively abundant supply, are relatively inexpensive, and provide an adequate source of nitrogen. However, there are a number of problems with these traditional materials as follows.

(a) Odour. The animal materials in particular emit a strong aroma which many people find offensive and which only dissipates when the material is totally degraded within the soil. This odour presents environmental problems during manufacture of the fertiliser, and causes a strong smell when applied to the garden. In some cases (eg manure) the aroma is so strong as to prevent the fertiliser being widely used on indoor plants.

(b) High salt content. Kelp and fish offal in particular have relatively high levels of sodium chloride which with regular application can result in excessively high salt levels in soil, with detrimental effects on plant health.

(c) Low nitrogen level. Materials such as humus and animal manure have relatively low nitrogen levels on a dry weight basis, necessitating relatively larger amounts of the material to be applied to the soil compared to nitrogen-rich materials such as blood. flesh and vegetable protein extracts.

(d) Low solubility. Almost all the traditional materials have low solubility which presents difficulties in solubilising the materials for presentation in a liquid form.

Materials such as humus and manure have relatively high levels of fibrous material of low digestibility. This indigestible material either has to be removed by filtration or sedimentation (with subsequent reduction in nutritive value), or digested using expensive chemical or enzymatic techniques.

Animal materials such as flesh, feathers, blood etc have much lower levels of poorly-digestible fibrous material, but the protein in these materials generally requires extensive hydrolysis to effect solubility or ease of suspension. Hydrolysis normally is achieved by a combination of heat, strong alkali or acid, or enzymatic digestion.

Additionally, artificial fertilisers should desirably approximate as closely as possible the fertiliser available to a growing plant in its natural environment. In the natural cycle of fertilisation through decaying vegetable matter, the entire plant contents are returned to the soil and become available for assimilation by plants. It is thought that most of the organic components of the decaying vegetable matter undergo complete degradation to their elemental substances (carbon, hydrogen, oxygen etc) or almost complete degradation to small molecular weight compounds (water, monosaccharides, amino acids etc) which then are absorbed by plants. Thus, decaying vegetative matter can be regarded as the ideal fertiliser since (i) it has the ideal balance of nutrients being returned to the soil in the ratio required by the plant, and (ii) it is returning to the soil all

plant components including those which may be absorbed either partially or completely intact by the plant.

Plant pigments are part of this latter group. Pigments serve a variety of functions in plants, but one important function is that of absorption of sunlight in order to provide the energy for photosynthesis. The two major pigments involved in this are the chlorophylls and the carotenoids. The chlorophylls (chlorophyll a and chlorophyll b) show two main peaks of light absorption in the red (670-680 nm) and blue (435-438 nm) regions of the spectrum. The carotenoids are made up of two classes of compounds - the carotenes and the xanthophylls. The four commonly occurring carotenoids of higher plants are β-carotene, lutein, violaxanthin and neoxanthin. The carotenoids show broad absorption peaks chiefly in the 450-600 nm region where the chlorophylls absorb relatively little light and this energy subsequently is transferred to chlorophyll a. Thus the carotenoids have the effect of complementing the light-absorbing capacity of the chlorophylls. The carotenoids also appear to play an additional role in preventing photo-oxidation of the chlorophylls. Other functions include (a) contributing importantly to the yellow-red colour of plants which is important to the fertility of plants in attracting pollenspreading insects and birds, and (b) contributing to the commercial worth of plants in terms of depth of colour.

Plants are able to synthesise these pigments *de novo,* and under normal conditions could be expected to have normal levels of pigments providing an adequate plane of nutrition is provided. However, it is known that intact pigments also can be absorbed directly from the soil. Although it is recognised that the bulk of pigments such as the carotenoids would be synthesised within the plant, a small proportion of pigments present may come directly from the soil. In this way, the normal process of fertilisation by decaying plant matter would supply a certain amount of carotenoid pigment for absorption by the plant.

There is a therefore a need for a fertiliser based either wholly or partly on organic matter, such matter

being of vegetable source and in a non-putrefied and non-putrefactive state (so as to avoid offensive odours),

having a relatively high nitrogen content on a dry weight basis (so as to minimise quantities to be applied),

having relatively low levels of poorly-digestible fibrous matter (to facilitate manufacture),

being readily hydrolysed or emulsified by inexpensive physical means (to facilitate manufacture),

having low salt content (so as to avoid risk of excessive salinity of soils), and

mimicking as closely as possible the cycle of natural fertilisation by providing

matter which contains at least small amounts of pigments such as chlorophylls and/or carotenoids, in particular xanthophylls.

No vegetable matter currently used in commercial fertilisers meets all of the requirements set out above.

OBJECTS OF INVENTION

Objects of this invention are to provide a fertiliser, a fertiliser composition, a fertiliser mixture, a process of preparing a fertiliser, a process of preparing a fertiliser composition and a fertiliser mixture, and a method of fertilising a plant.

DISCLOSURE OF INVENTION

As used herein the expression "alteration agent" refers to a chemical agent, such as a hydrolytic agent, or physical means that is capable of hydrolysing a protein, peptide, polypeptide or polypeptide bond or breaking a protein, peptide, polypeptide or polypeptide component into smaller polypeptides, smaller peptides and/or protein subunits, or otherwise converting insoluble proteinaceous material into a soluble or emulsifiable form.

As used herein the expression "protein containing vegetable matter" refers to vegetable matter which contains sufficient nitrogen in the form of protein to provide at least part of the nitrogen requirements of growing plants when the proteinaceous vegetable matter is included in a fertiliser.

As used herein the expression "altered protein containing vegetable matter" refers to protein containing vegetable matter which has been altered by the action of an alteration agent: this expression refers to mixtures which include polypeptides; mixtures of proteins and polypeptides; proteins, polypeptides and amino acids; or polypeptides and amino acids which are prepared by altering proteins of vegetable matter with an alteration agent. Generally, the protein containing vegetable matter is any protein-containing plant matter which has low levels of sodium and chloride ions. Generally, the protein containing vegetable matter is a cereal, typically containing at least one carotenoid, more typically containing at least one xanthophyll. Typically, the altered protein containing vegetable matter is in a non-putrefied and non-putrefactive state.

As used herein the expression "gluten" refers to the nitrogenous substance remaining when the flour from vegetable matter is washed to remove the starch. Generally the vegetable matter is a cereal.

As used herein the expression "buffering agent" refers to any agent which can absorb changes in pH.

As used herein the expression "carotenoid" refers to tetraterpene-related pigments, including carotenes and their oxygenated derivatives such as xanthophylls, carotenoid acids and their esters. Examples of carotenoids are α-carotene, β-carotene, γ-carotene,

lycopene, cryptoxanthin, lutein, zeaxanthin, canthaxanthin, citranaxanthin, violaxanthin, rhodoxanthin, rubixanthin, ethyl β-apo-8'-carotenoate, β-apo-8'-carotenal, bixin, norbixin, crocetin, crocin and lycophyll.

As used herein, the term "plant growth enhancing amount of at least one carotenoid" refers to an amount of the carotenoid(s) which, when applied to a plant, or the locus of a plant, or to soil or water containing seed or other propagating organs of a plant, causes the growth of the plant to be enhanced relative to the growth of an identical plant to which no carotenoid(s) are applied.

One advantage of cereal-derived vegetable matter is that it is generally a rich source of vegetable protein and has low levels of sodium and chloride ions. Corn gluten is particularly preferred as it has significant levels of carotenoids as well as high levels of protein. By the expression "low levels of sodium and chloride ions" is meant lower quantities of sodium and chloride ions than are found in plant matter which grows in salt water, such as kelp.

According to a first embodiment of this invention there is provided a plant fertiliser comprising at least one fertiliser component and a plant growth enhancing amount of at least one carotenoid. In a first form of this embodiment, the fertiliser component is selected from the group consisting of a known inorganic fertiliser component and a known organic fertiliser component. In a second form of this embodiment, the fertiliser component comprises altered protein containing vegetable matter, as herein defined, and/or gluten, as herein defined. Typically, in this form, the altered protein containing vegetable matter has a plant growth enhancing amount of at least one carotenoid.

According to a second embodiment of this invention there is provided a fertiliser composition comprising:

at least one fertiliser of the first embodiment; and

an agriculturally acceptable carrier, diluent, and/or adjuvant and optionally a suspending agent.

Typically, in this embodiment, the fertiliser component comprises altered protein containing vegetable matter having a plant growth enhancing amount of at least one carotenoid.

According to a third embodiment of this invention there is provided a fertiliser mixture, comprising a fertiliser of the first embodiment or a fertiliser composition of the second embodiment in combination with at least one known inorganic or organic fertiliser component. Typically, in this embodiment, the fertiliser or fertiliser composition comprises altered protein containing vegetable matter having a plant growth enhancing amount of at least one carotenoid.

According to a fourth embodiment of this invention, there is provided a process of preparing a plant fertiliser, comprising dissolving or suspending in water at least one

fertiliser component and a plant growth enhancing amount of at least one carotenoid. In a first form of this embodiment, the fertiliser component is selected from the group consisting of a known inorganic fertiliser component and a known organic fertiliser component. In a second form of this embodiment, the fertiliser component comprises altered protein containing vegetable matter, as herein defined, having a plant growth enhancing amount of at least one carotenoid.

In this second form, the process of the fourth embodiment comprises:

altering at least one organic fertiliser component comprising protein containing vegetable matter by treating said component with an alteration agent to form the fertiliser, wherein the fertiliser comprises altered protein containing vegetable matter, as herein defined. Typically, in this form of the fourth embodiment, the protein containing vegetable matter contains at least one carotenoid.

This second form of the process of the fourth embodiment may also include the step of:

separating proteins and polypeptides from the altered protein containing vegetable matter wherein the separated proteins and polypeptides comprise the organic fertiliser component. Typically in this process, carotenoid(s) are also separated from the altered protein containing vegetable matter along with the proteins and polypeptides, and the separated carotenoid(s), proteins and polypeptides comprise the organic fertiliser component.

The proteins and polypeptides may be separated according to molecular weight, solubility, hydrophobicity and/or molecular charge.

The second form of the process of the fourth embodiment may also include the step of:

heating the mixture of the protein containing vegetable matter and the alteration agent to accelerate the alteration of the protein containing vegetable matter. Typically the mixture is heated at a temperature in the range of from about 30°C to about 100°C for between 3 minutes to 20 hours, more typically 15 minutes to 3 hours.

The second form of the process of the fourth embodiment may also include the step of adding one or more known inorganic or organic fertilisers to the altered protein containing vegetable matter to produce an inorganic/organic fertiliser mixture.

The process of the fourth embodiment may also include the step of adjusting the pH of the fertiliser. Typically, the pH of the fertiliser is adjusted in the range of from 1.5 to 12, more typically from 2 to 4, even more typically from about 2.3 to about 2.5, at which pH microbial decomposition of the fertiliser during storage is inhibited.

The process of the fourth embodiment may also include the step of adding a chemical preservative to the fertiliser to preserve the fertiliser.

The process of the fourth embodiment may also include the step of adding a fragrance or perfume to the fertiliser to perfume the fertiliser.

Generally in the second form of the process of the fourth embodiment, the protein containing vegetable matter is treated with the alteration agent under conditions such that the resultant altered protein containing vegetable matter is at least partially water soluble or forms an emulsion with water.

According to a fifth embodiment of this invention, there is provided a fertiliser when prepared by the process of the fourth embodiment.

The amount of the carotenoid(s) in the fertiliser of the invention depends on the degree of dilution of the fertiliser. Typically, in the fertiliser of the first or fourth embodiments, the fertiliser mixture of the second embodiment and the fertiliser composition of the third embodiment, the plant growth enhancing amount of the at least one carotenoid is in the range of from about 0.01 mg/L to about 500 mg/L of the fertiliser if in the liquid form, or from about 0.01 mg/kg to about 500 mg/kg of the fertiliser if in the dry or solid form. More typically, the plant growth enhancing amount of the at least one carotenoid is from about 0.05 mg/L to about 500 mg/L, even more typically from about 0.1 mg/L to about 100 mg/L, still more typically from about 0.2 mg/L to about 5 mg/L.

According to a sixth embodiment of this invention, there is provided a process of preparing a fertiliser composition, comprising:

mixing an agriculturally acceptable carrier, diluent, and/or adjuvant and optionally a suspending agent with a fertiliser of the first or fifth embodiments.

According to a seventh embodiment of this invention, there is provided a process of preparing a fertiliser mixture, comprising:

mixing a fertiliser of the first or fifth embodiments or a fertiliser composition of the second embodiment with at least one known inorganic or organic fertiliser.

According to an eighth embodiment of this invention, there is provided a fertiliser composition whenever prepared by the process of the sixth embodiment.

According to a ninth embodiment of this invention, there is provided a fertiliser mixture whenever prepared by a process of the seventh embodiment.

According to a tenth embodiment of this invention, there is provided a method of fertilising a plant comprising applying to the foliage of the plant or to the locus of the plant or to soil or water containing seeds or other propagating organs thereof, an effective amount of a fertiliser as defined in the first or fifth embodiments or a fertiliser composition of the second or eighth embodiments or a fertiliser mixture of the third or ninth embodiments.

It has been found that the method of the tenth embodiment provides for particularly improved growth and plant vigour when the plant is a flowering plant or shrub, or a leafy vegetable. Thus growth and flower quality of flowering plants and shrubs are enhanced by the method of the tenth embodiment, and the quantity and quality of edible leaves in leafy vegetables are enhanced.

Typically, in the first to tenth embodiments, the protein containing vegetable matter is gluten, more typically cereal gluten, even more typically corn gluten. Generally, the protein containing vegetable matter comprises one or more xanthophylls.

The fertiliser composition of the invention may be in either a liquid form or a dry form. Generally, when the fertiliser composition of the invention is in the dry form, the protein containing vegetable matter is gluten. Typically, the gluten is corn gluten.

Generally the fertiliser composition comprises 0.1-99.9 wt% fertiliser and 99.9-0.1 wt% of an agriculturally acceptable carrier, diluent and/or adjuvant and optionally a suspending agent. Typically the fertiliser mixture comprises 0.1-99.9 wt% fertiliser or fertiliser composition and 99.9-0.1 wt% of at least one known inorganic or organic fertiliser, more typically from 1 to 95 wt% of the fertiliser or fertiliser composition, even more typically from 10 to 90 wt% of the fertiliser or fertiliser composition, still more typically from 50 to 80 wt% of the fertiliser or fertiliser composition.

The protein containing vegetable matter generally contains a rich source of vegetable protein and low levels of sodium and chloride ions. It is preferable that the protein containing vegetable matter has relatively low levels of fats, about 4-8 wt%, and low levels of fibre, about 1.0-2.5 wt%. Typically the protein containing vegetable matter is selected from cereal-derived vegetable matter. Generally the protein containing vegetable matter is a cereal-derived fertiliser component and has about 60-70 % protein content. Generally the protein containing vegetable matter has about 0.01-0.1 wt% carotenoid content. Examples of cereal-derived vegetable matter include whole extracts or protein-enriched isolates from corn, soya, cottonseed, linseed, wheat, barley, safflower, sunflower, rapeseed, rye, rice, millet, triticale, sorghum, oat, Chinese naked oat, tef grass, two-row barley, African millet, Italian millet, Broom corn millet, spiked millet, Pearl millet, emmer, Abyssinian hard wheat, Einkorn wheat, sweet corn, grain amaranth, buckwheat, rye buckwheat, groundnut, peanut, Pigeon pea, chickpea, Hyacinth bean, Manchurian soya, soyabean, wild soya, grass pea, lentil, cowitch, Florida velvet bean, tepary bean, mung, green gram mung, lima bean, sieva bean, scarlet runner bean, black gram, french bean, common bean, kidney bean, dwarf bean, horse bean, broad bean, Adzuki bean, asparagus, cowpea, durum wheat or mixtures thereof or other like cereals.

Preferred examples of cereal-derived protein containing vegetable matter include whole extracts or protein-enriched isolates from corn gluten, soya gluten, cottonseed gluten, linseed gluten, wheat gluten, barley gluten, safflower gluten, sunflower gluten, rapeseed gluten, rye gluten, rice gluten, millet gluten, triticale gluten, sorghum gluten, oat gluten, Chinese naked oat gluten, tef grass gluten, two-row barley gluten, African millet gluten, Italian millet gluten, Broom corn millet gluten, spiked millet gluten, Pearl millet gluten, emmer gluten, Abyssinian hard wheat gluten, Einkorn wheat gluten, sweet corn gluten, grain amaranth gluten, buckwheat gluten, rye buckwheat gluten, groundnut

gluten, peanut gluten, Pigeon pea gluten, chickpea gluten, Hyacinth bean gluten, Manchurian soya gluten, soyabean gluten, wild soya gluten, grass pea gluten, lentil gluten, cowitch gluten, Florida velvet bean gluten, tepary bean gluten, mung gluten, green gram mung gluten, lima bean gluten, sieva bean gluten, scarlet runner bean gluten, black gram gluten, french bean gluten, common bean gluten, kidney bean gluten, dwarf bean gluten, horse bean gluten, broad bean gluten, Adzuki bean gluten, asparagus gluten, cowpea gluten, durum wheat gluten or mixtures thereof or other like glutens derived from vegetable matter.

The protein containing vegetable matter may also be derived from bran. The bran may be coarse or fine or a mixture thereof of any cereal bran including wheat, rye, corn, rice, millet, sorghum, maize, soya, cottonseed, linseed, safflower, sunflower, rapeseed, triticale, barley, oat, Chinese naked oat, tef grass, two-row barley, African millet, Italian millet, Broom corn millet, spiked millet, Pearl millet, emmer, Abyssinian hard wheat, Einkorn wheat, sweet corn, grain amaranth, buckwheat, rye buckwheat, groundnut, peanut, Pigeon pea, chickpea, Hyacinth bean, Manchurian soya, soyabean, wild soya, grass pea, lentil, cowitch, Florida velvet bean, tepary bean, mung, green gram mung, lima bean, sieva bean, scarlet runner bean, black gram, french bean, common bean, kidney bean, dwarf bean, horse bean, broad bean, Adzuki bean, asparagus, cowpea, durum wheat or any mixture thereof or bran of other like grain or mixture thereof. Preferably about 0.1 to 99.9 wt%, more preferably 1 to 95 wt%, even more preferably 10 to 90 wt% and still more preferably 50 to 80 wt% corn gluten is used in the fertiliser or fertiliser composition of the invention.

Corn gluten is the preferred protein containing vegetable matter in the invention for the following reasons:

(a) in common with a number of other sources of vegetable protein, corn gluten has no offensive odour and is less liable to putrefaction than is animal protein;

(b) further in common with a number of other sources of vegetable protein, corn gluten is available commercially in a dried form which readily lends itself to hydrolysis by relatively inexpensive physical methods;

(c) further in common with a number of other sources of vegetable protein but excluding kelp, corn gluten has an acceptably low salt content;

(d) compared to other readily available raw vegetable matter or common by-products of vegetable origin, gluten has the highest protein level (typically 68%);

(e) compared to other forms of gluten, corn gluten has the highest levels of carotenoid plant pigments;

(f) corn gluten as a by-product of the maize industry is in plentiful supply.

It has been surprisingly found by the inventor that the application of a fertiliser in

accordance with the present invention containing significant amounts of carotenoids results in superior plant growth in comparison to the application of a similar fertiliser which does not contain carotenoids. The mechanism by which this enhanced plant growth occurs is unclear, but, without wishing to be bound by any particular theory, it is believed that (a) absorption by plants of carotenoids from the soil occurs leading to higher levels of carotenoids in the growing plants, resulting in more efficient absorption of ultraviolet light and superior photosynthesis; and (b) the presence of carotenoids in soil enhances the activity of soil-borne micro-organisms.

The protein containing vegetable matter may be altered with an alteration agent. Generally alteration agents may be proteases, lipases, phosphatases, carbohydrases, esterases, nucleases, acids, alkalis, temperature, organic solvents miscible with water, e.g. acetone, methanol or ethanol, mercaptides, e.g. 2-mercaptoethanol, physical methods, e.g. ultra-sonication, micro-wave irradiation, application of shearing forces such as in an emulsification pump, and mixtures thereof or other like alteration agents. Typically, the altering agent comprises the application of shearing forces.

Generally proteases may be prepared from vegetable extracts, e.g. cereal grain gum, papaya extracts (papain), tropical fig extracts (ficin); fungal extracts , e.g. Aspergillus oryzae extracts; microbial and bacterial extracts, e.g. Escherichia coli; animal extracts, e.g. pancreatic enzymes, stomach enzymes, other digestive gland enzymes; or other like extracts. Typically, proteases include papain, pepsin, bromelain, lysozyme, trypsin, chymotrypsin, renin, subtilisin, ficin, carboxypeptidase, aminopeptidase and other like proteases.

Typical lipases include pancreatic lipase, steapsin, or other like lipases. General carbohydrases include a-amylase, sucrase, maltase or other like carbohydrases. Typical phosphatases include fructose-1,6-diphosphatase, glucose 6-phosphatase or other like phosphatases. General nucleases include ribonuclease, deoxyribonuclease or other like nucleases. Acids typically hydrochloric acid, sulphuric acid, nitric acid, phosphoric acid, mixtures thereof or other like acids. Alkalis generally include sodium hydroxide, potassium hydroxide, mixtures thereof or other like alkalis. Typically about 1 to 10 wt% of alteration agent is used.

Enzymatic activity may be dependent on pH, ionic strength, temperature and metal ion requirements. Buffering agents generally determine and maintain pH. Examples of buffering agents include phosphate, tris(hydroxymethyl)aminomethane, amino acids, citrate, acetate, succinate, maleate, cacodylate, barbital, carbonate, sulphate or mixtures thereof or other like buffering agents. The pH for enzymatic activity and other alteration agents may range from 0 to 14.

Ionic strength may be maintained by the addition of salts. Examples of salts include sodium chloride, potassium chloride, lithium chloride, caesium chloride, sodium bromide, potassium bromide, lithium bromide, caesium bromide, sodium iodide,

potassium iodide, lithium iodide, caesium iodide, sodium sulphate, sodium nitrate and other like salts or mixtures thereof may be used.

The temperature range for enzymatic activity may vary from 0°C to 100°C, depending on the type of enzyme and for other alteration agents, the temperature range may vary from -80°C to 110°C.

Enzymatic activity requiring metal ions may be met by the addition of calcium, copper, magnesium, manganese, sodium, potassium, zinc and other like metal ions or mixtures thereof.

Examples of agents for adjusting pH are inorganic acids such as phosphoric acid, sulfuric acid, nitric acid and hydrochloric acid, organic acids such as acetic acid, citric acid and succinic acid, and alkalies such as sodium hydroxide, potassium hydroxide, ammonia and lime.

Generally the organic fertiliser component is altered to a level to ensure approximate even distribution in the agriculturally acceptable carrier, diluent, and/or adjuvant and suspending agent. Preferably continuous agitation during distribution will not be required.

Generally about 99.9 to 0.1 wt% of an agriculturally acceptable carrier, diluent, and/or adjuvant and optionally suspending agent is used in the fertiliser composition. Solid carriers may include flour, bran, ground rice, calcium carbonate, calcium sulphate, synthetic hydrated, silicon oxides and synthetic calcium or aluminium silicates, diatomaceous earths or charcoal, vermiculite, mica, kaolin, calcite, talcum, montmorillonite or attapulgite or other like carriers. In order to improve the physical properties it is also possible to add highly dispersed silicic acids or highly dispersed absorbent polymers. Suitable granulated adsorptive carriers are porous types, for example pumice, broken brick, sepiolite or bentonite; and suitable nonsorbent carriers are calcite or sand. In addition, a great number of granulated materials of inorganic or organic nature may be used, e.g. dolomite. A preferred solid carrier is ground rice hulls.

Generally diluents include sodium phosphate, calcium phosphate, sodium carbonate, calcium carbonate, kaolin, water, a salt solution, a sugar solution, or an oil such as peanut oil, olive oil, fruit oil, or other like diluents. Water is the preferred diluent. Typically, when diluted in water, the fertiliser of the invention is in a concentraion of from about 1g/L to about 500 g/L, depending on the degree of dilution. In a form suitable for application to plants, a diluted fertiliser of the invention has a solids concentration of from about 1g/L to about 5g/L.

Generally adjuvants include surfactants. The surfactants may include anionic surfactants such as water-soluble soaps, e.g. alkali metal soaps, or water-soluble synthetic surface active compounds, e.g. fatty sulphonates. Non-ionic surfactants such as polyglycol ether derivatives of aliphatic or cycloaliphatic alcohols may be used.

Cationic surfactants such as quaternary ammonium salts may also be used.

Generally suspending agents include chemical agents. Examples of chemical agents include water, detergents, sodium carboxymethylcellulose, methylcellulose, hydroxypropylmethylcellulose, sodium alginate, polyvinylpyrrolidone, gum tragacanth and gum acacia, or mixtures thereof.

Binders may be used in the fertiliser or fertiliser composition of the invention. Generally binders may include such substances as starch, alginate, carboxymethylcellulose, agarose, hydroxypropylcellulose, gelatin, locust bean gum, tamarind, gum acacia, gum tragacanth, guar gum, pectin, carrageenan or other like binders.

A slow release fertiliser may be prepared using suitable sustained released adducts including agarose, agar, flour, cellulose, hemicellulose including xylan, carboxymethylcellulose, dextran, dextrin-starches including amylose, glucans like lichenin, nigeran and glycogens, fructans including inulin, galactans, mannans, polyuronides including gums and mucilages, fucoidin, or derivatives thereof.

The known inorganic fertiliser component for use in the fertiliser of the first embodiment or the fertiliser mixture of the third embodiment may be or include elements or compounds which include nitrogen, phosphorous, potassium, calcium, magnesium, sulphur, copper, zinc, boron, molybdenum, iron, manganese, chlorine, ammonia, ammonium nitrate, zeolite, manganese sulphate, normal superphosphate, triple superphosphate, sodium molybdate, calcium nitrate, potassium nitrate, copper sulphate, monoammonium phosphate, magnesium sulphate, ferric sulphate, sodium borate, zinc sulphate, mixtures thereof or other like inorganic fertiliser components.

The known organic fertiliser component for use in the fertiliser of the first embodiment or the fertiliser mixture of the third embodiment may be or include sewerage sludge, animal offal such as blood, bone or meat meal, animal excreta, such as manure or urea, or decaying vegetable matter such as compost, humus or peat moss.

The fertiliser of the invention may further comprise additives such as insecticides, herbicides, fungicides, pesticides, miticides, nematicides, preservatives, antimicrobials, perfumes or fragrances or mixtures thereof. These will usually be in an amount about 0.1 to 99 wt%.

Generally insecticides include chlorinated hydrocarbons, organophosphates, carbamates, or synthetic pyrethroids. Examples of these insecticides include aldrin, allethrin, g-BHC, carbaryl, chlordane, cypermethrin, DDT, decamethrin, diazinon, dieldrin, diflubenzuron, dimetan, endrin, fenvalerate, heptachlor, lindane (a-BHC), malathion, mirex, parathion, phenothrin, phorate, pyrethrin I, pyrethrin II, strobane, toxaphene.

Generally herbicides include phenoxy alkanoic acids, s-triazines, phenylcarbamates, phenylureas, dinitrobenzenes, benzoic acids, thiocarbamates, anilides,

dipyridyls, chlorinated aliphatic acids, uracils, phenols, organoarsenical compounds, or diphenyl ethers. Examples of these herbicides include agent orange, alachlor, amitrole, atrazine, bensulide, cacodylic acid, chloramben, chloroxuron, chlorpropham, 2,4-D, dacthal, dalapon, 2,4-DB, diquat, diuron, DSMA, fenac, fenuron, glyphosate, linuron, MCPA, metobromuron, metolachlor, monuron, neburon, nitralin, paraquat, picloram, propanil, propham, silvex, simazine, 2,4,5-T, TCA, trifluralin.

Generally fungicides include sulphur, copper, mercury, carbamate, imidazoline, quinone, or guanidine. Examples of these fungicides include Bordeaux mixture, captan, ethyl mercuric acetate, ferbam, mancozeb, maneb, mercurous chloride, mercuric chloride, metiram, nabam, PMA, semesan, zineb.

Typical nematicides include DBCP, permethrin, vapam. Typical miticides include kepone, mevinphos, permethrin.

Usual preservatives include glycerine, formalin, sodium benzoate and lower carboxylic acids. Preferably an additive is added to facilitate the uptake of the preservative. Typical additives include dimethyl sulfoxide, glyme, diglyme, triglyme, dioxane, pyridine, dimethyl formamide, acetone, tetrahydrofurane, acetonitrile and 1-methyl-2-pyrrolidone.

Typical antimicrobials include antibacterials such as penicillin, amoxycillin, phenol, paraben, chlorobutamol, sorbic acid, sulphur drugs, strongly acidic pH, strongly alkaline pH, 1-phenoxyphenyl-1-triazolylmethyl-carbinols or mixtures thereof.

Typical perfumes or fragrances include naturally occurring oils such as ambergris, benzoin, castoreum, civet, clove leaf oil, jasmine absolute, myrrh, musk tonquin, mimosa, rosemary oil, or sandalwood oil or synthetic aroma chemicals such as benzyl acetate, citronellol, geraniol, linalool, musk ambrette, or terpinyl acetate.

The protein containing vegetable matter may also comprise further additives such as stabilisers, e.g. vegetable oils or epoxidised vegetable oils (epoxidised coconut oil, peanut oil, olive oil, rape oil or soybean oil), antifoams, e.g. silicone oil, preservatives, viscosity regulators, as well as tackifiers.

The fertiliser, fertiliser composition or fertiliser mixture of the invention may be prepared in the form of granules.

Typically the fertiliser is prepared as a concentrated solution. This solution may be further concentrated to form a thick slurry or concentrated to dryness and stored as a solid. The solution may be diluted for application to plant foliage or to soil. Typically the fertiliser is diluted to a concentration range of about 1 part fertiliser:1 part water to about 1 part fertiliser:1000 parts water, more typically, the fertiliser is diluted from 1 part:250 parts water to 1 part:100 parts water. The fertiliser composition may be diluted for application to plant foliage or to soil. Typically the fertiliser composition may be diluted to a concentration range of about 1 part fertiliser composition:1 part water to about 1 part fertiliser composition:1000 parts water, more typically from 1 part:250

parts water to 1 part:100 parts water. The fertiliser mixture may be diluted for application to plant foliage or to soil. Typically the fertiliser mixture is diluted to a concentration range of about 1 part fertiliser mixture:1 part water to about 1 part fertiliser mixture:1000 parts water, more typically from 1 part:250 parts water to 1 part:100 parts water.

The diluted fertiliser, diluted fertiliser composition and/or diluted fertiliser mixture may be applied to the foliage of plants or to soil as required. The diluted fertiliser, diluted fertiliser composition and/or diluted fertiliser mixture may be applied hourly, daily, weekly, fortnightly, monthly, yearly, continuously or whenever required by the plant. Generally the diluted fertiliser, diluted fertiliser composition and/or diluted fertiliser mixture is applied at daily, weekly or fortnightly intervals, more generally at fortnightly intervals.

Alternatively, when the protein containing vegetable matter is gluten, a dry form of the fertiliser of the present invention may be prepared by mixing the gluten with one or more known inorganic fertilisers, optionally adding a solid carrier and optionally one or more additives such as insecticides, herbicides, fungicides, pesticides, miticides, nematicides, preservatives, antimicrobials, perfumes or fragrances or mixtures thereof. Generally, this form of the fertiliser of the invention includes a solid carrier. Typically, the solid carrier is ground rice hulls. Generally, in this form, the fertiliser of the invention is pressed or formed into pellets, sticks, discs, granules, beads, tablets, or other suitable shapes. Typically, the mixture is pressed into pellets.

The fertiliser in the dry form may diluted with water, or it may be distributed manually over the surface of soil to be fertilised, or it may be dug, pressed, hoed, raked or otherwise introduced into the soil. The dry form fertiliser may be applied daily, weekly, fortnightly, monthly, yearly or whenever required by the plant. Generally the dry form fertiliser is applied at fortnightly intervals.

The grade of the fertiliser defines the nutritive content. Generally the nutritive content may vary from 66% N:66% P:66% K (66:66:66) to 0.5% N:0.5% P:0.5% K (0.5:0.5:0.5). Preferably the nutritive content varies from 8.4:2.0:4.0 to 5.0:1.2:2.0. The organic nitrogen level may vary from 0.1% to 20%, preferably 2% to 5%.

Generally the amount of fertiliser applied to the foliage of the plant or to the locus of the plant or to the soil or water containing seeds or other propagating organs thereof varies from 1 litre of undiluted fertiliser per square metre to 1 litre of diluted fertiliser (1 part fertiliser:1000 parts water) per square metre. Preferably 1 litre of diluted fertiliser (diluted 1 part fertiliser:250 parts water or 1 part fertiliser:100 parts water) per square metre is applied.

Generally the amount of fertiliser composition applied to the foliage of the plant or to the locus of the plant or to the soil or water containing seeds or other propagating organs thereof varies from 1 litre undiluted fertiliser composition per square metre to 1

litre diluted fertiliser composition (1 part fertiliser composition:1000 parts water) per square metre. Generally the amount of fertiliser mixture applied to the foliage of the plant or to the locus of the plant or to the soil or water containing seeds or other propagating organs thereof varies from 1 litre undiluted fertiliser mixture per square metre to 1 litre diluted fertiliser mixture (1 part fertiliser mixture:1000 parts water) per square metre.

Typically, in the method of the tenth embodiment, the plant to which the fertiliser, fertiliser composition or fertiliser mixture is applied is a flowering plant or shrub, or a leafy vegetable.

Examples of flowering plants or shrubs on which the method of the tenth embodiment may be used are Abelia, Acroclinium, African marigold (*Tagetes erecta*), African violet (*Saintpaulia sp.*), Agapanthus, Ageratum, Alyssum (*Lobularia maritima),* Amaranthus, Anemone, Antirrhinum, Aphelandra, Artemesia, Arum lily (*Zantedeschia sp.*), Aster, Aurora daisy (*Arctotis sp.*), Australian native violet (*Viola hederacea*), Autumn crocus (*Colchium autumnale*), Azalea, Balloon flower (*Platycodon grandiflorus*), Balsam (*Impatiens balsamina*), Begonia, Bellflower (*Campanula sp.*), Bird of Paradise flower (*Strelitzia sp.*), Blue butterfly bush (*Clerodendrum ugandense*, Blue ginger (*Dichorisandra sp.*), Bluebells (*Scilla sp.*), Bonfire salvia (*Salviasplendens sp.*), Boronia, Bottlebrush (*Callistemon sp.*), Bougainvillea, Brachycome, Brazilian plume flower (*Justicia carnea*), Bugle (*Ajuga sp.*), Butterfly bush (*Buddleia davidii*), Calceolaria, Calendula, Calla lily (*Zantedeschia sp.*), Camellia, Candytuft (*Iberis sp.*), Canna, Canterbury bell (*Campanula medium*), Carnation (*Dianthus caryophyllus*), Cassia, Celosia, Centaurea, Cherry pie (*Heliotropium aborscens*), China aster (*Callistephus sp.*), Chinese forget-me-not (*Cynoglossum sp.*), Chinese foxglove (*Rehmannia sp.*), Chinese lantern (*Abutilon sp.*), Chinese poppy (*Eomecon*), Chrysanthemum, Cineraria, Clematis, Cleome, Clerodendron, Coast rosemary (*Westringia fruticosa*), Coleus, Columbine (*Aquilegia sp.*), Coneflower (*Rudbeckia sp.*), Corn cockle (*Agrostemma sp.*), Cornflower (*Centaurea cyanus*), Cosmos, Crepe myrtle (*Lagerstroemia indica*), Cyclamen, Cyclamen, Daffodil (*Narcissus sp.*), Dahlia, Daphne, Darling lily (*Crinum flaccidum*), Daylily (*Hemerocallia sp.*), Delphinium, Devil-in-a-fog (*Nigella damascena*), Dianthus, Diosma, English daisy (*Bellis perennis*), Eschscholtzia, Evening primrose (*Oenothera sp.*), Everlasting daisy (*Helichrysum sp.*), Fairy Pinks, Fan flower (*Scaevola sp.*), Flannel flower (*Actinotus sp.*), Forget-me-not (*Myosotis sp.*), Foxglove (*Digitalis sp.*), Frangipani (*Plumeria sp.*), Freesia, French lavender (*Lavendula dentata*), French marigold (*Tagetes patula*), Fuchsia, Gaillardia, Gardenia, Gazania, Geraldton wax (*Chamelaucium uncinatum*), Geranium (*Pelargonium sp.*), Gerbera, Ginger lily (*Hedychium sp.*), Gladiolus, Globe amaranth (*Gomphrena globosa*), Glory bush (*Tibouchina sp.*), Glory lily (*Gloriosa superba*), Gloxinia, Godetia (*Clarkia sp.*), Gomphrena, Granny's bonnets (*Angelonia sp.*), Grape hyacinth (*Muscari sp.*),

Grevillea, Guinea flower (*Hibbertia sp.*), Gypsophila, Hardenbergia, Heartsease (*Viola tricolor*), Helichrysum, Heliotrope (*Heliotropium arborescenes*), Hellebore (*Helleborus sp.*), Hibiscus, Hollyhock (*Alcea sp.*), Honesty (*Lunaria sp.*), Honeysuckle (*Lonicera sp.*), Hound's tongue (*Cynoglossum sp.*), Hoya, Hyacinth, Hydrangea, Hypericum, Iceland poppy (*Papaver nudicaule*), Impatiens, Iris, Jacaranda, Jasmine (*Jasminum sp.*), Jonquil (*Narcissus jonquilla*), Kidney weed (*Dichondra repens*), Kochia, Larkspur (*Consolida sp.*), Lasiandra (*Tibouchina sp.*), Lavender (*Lavendula sp.*), Lilac, Lily-of-the-valley (*Convallaria sp.*), Lily (*Lilium sp.*), Linaria, Livingstone daisy (*Dorotheantus bellidiformis*), Lobelia, Lobster claw (*Heliconia humilis*), Love-in-a-mist (*Nigella damascena*), Lupin (*Lupinus sp.*), Madagascar periwinkle (*Catharanthus roseus*), Magnolia, Marguerite daisy (*Chrysanthemum frutescens*), Marigold (*Calendula sp.*), Mexican sage bush (*Salvia leucantha*), Mignonette (*Reseda odorata*), *Mina Lobata*, Mint bush (*Prostanthera sp.*), Mock erica (*Physostegia sp.*), Molucella, Monkey mask (*Mimulus sp.*), Morning glory (*Ipomoea sp.*), Nasturtium (*Tropaeolum sp.*), Nemesia, Nemophila, Nigella, November lily (*Lilium longiflorum*), Nutmeg bush (*Iboza riparia*), Oleander (*Nerium oleander*), Orchid, Ornamental Basil, Ornamental Chilli, Pansy (*Viola* x *wittrockiana*), Peony, Periwinkle (*Vinca sp.*), Petunia, Philippine violet (*Barleria cristata*), Phlox, Pigeon berry (*Duranta repens*), Pigface (*Lampranthus sp.*, *Mesembryanthemum sp.*), Pineapple lily (*Eucomis sp.*), Pink evening primrose (*Oenothera speciosa rosea*), Poinsettia, Poison lily (*Crinum asiaticum*), Polyanthus, Polygala, Poppy, Portulaca, Pride of Madiera (*Echium fatuosum*), Primula, Ranunculus, Red ginger lily (*Hedychium coccineum*), Rhididendron, Rice flower (*Pimela sp.*), Rose (*Rosa sp.*), Rudbeckia, Salpiglossis, Salvia, Saponaria, Scabiosa, Schizanthus, Shasta daisy (*Chrysanthemum maximum*), Shrimp plant (*Drejerella guttata*), Snow-in-summer (*Cerastium tomentosum*), Snow poppy (*Eomecon sp.*), Snowdrop (*Galanthus sp.*), Snowflake (*Leucojum sp.*), Solomon's seal (*Polygonatum sp.*), Spanish broom (*Spartium junceum*), Spider flower (*Cleome sp.*), Spider lily (*Nerine sp.*), Star daisy (*Linaheimera texana*), Statice (*Limonium sp.*), Stock (*Matthiola sp.*), Stoke's aster (*Stokesia sp.*), Sunflower (*Helianthus sp.*), Swamp lily (*Crinum pedunculatum*), Swan River Daisy (*Brachycome iberidifolia*), Sweet Alice (*Lobularia maritima*), Sweet pea (*Lathyrus odoratus*), Sweet William (*Dianthus barbatus*), Tea tree (*Leptospermum sp.*), Thrift (*Armeria sp.*), Tobacco (*Nicotiana sp.*), Torenia, Tuberose (*Polianthes tuberosa*), Tulip (*Tulipa sp.*), Valerian (*Valeriana sp.*), Verbena, Veronica (*Hebe sp.*), Viburnum, Viola, Virginian stock (*Malcolmia maritima*), Viscaria, Wallflower (*Chieranthus sp.*), Willow myrtle (*Agonis sp.*), Windflower (*Anemone sp.*), Wisteria, Yellow ginger lily (*Hedychium gardenerianum*), and Zinnia.

Examples of leafy vegetables on which the method of the tenth embodiment may be used are Artichoke, Asparagus, Basil, Beetroot Borecole, Borage, Broccoli, Brussels sprout, Cabbage, Cauliflower, Celeriac, Celery, Chervil, Chicory, Chinese cabbage,

Cress, Endive, Fennel, Hyssop, Kale, Kohl rabi, Lemon balm, Lettuce, Marjoram, Mint, Mustard, Oregano, Parsley, Rhubarb, Rosemary, Sage, Silver beet, Sorrel, Spinach, Tarragon, Thyme and Water cress.

The use of cereal-derived vegetable matter as a source of organic material, compared to animal materials, offers a number of technical and commercial advantages. They are: (1) cereal-derived vegetable matter, and corn gluten in particular, are a rich source of plant carotenoids, whereas animal matter typically would be low in such molecules; (2) protein and fat of vegetable origin typically has a less offensive smell than animal proteins and fats in a liquid form: thus, the process of fertiliser manufacture using cereal-derived vegetable matter will be less offensive than that using animal matter; (3) cereal-derived vegetable matter, and corn gluten in particular, has significantly less indigestible material than most commercially-available animal by-products available for fertiliser manufacture, meaning that the product does not have to be screened at the end of the manufacturing process, and leaving no residue to be disposed of, both factors effecting a significant cost-saving; (4) cereal-derived vegetable matter, and corn gluten in particular, is more readily digested than dried animal by-products available for fertiliser manufacture: typically, hydrolysis of corn gluten by potassium hydroxide is complete in 30 minutes compared to between 2-4 hours for animal matter such as dried blood or meat meal or feathermeal; (5) cereal-derived vegetable matter, and corn gluten in particular, is more readily emulsified by pumping and is more readily hydrolysed by physical agitation than are other high protein vegetable materials such as soya flour or animal protein sources such as meat or fish meal. Thus a significantly more efficient manufacturing process is possible using corn gluten than other protein sources.

BEST MODE AND OTHER MODES FOR CARRYING OUT THE INVENTION

In a preferred form of the invention altered protein containing vegetable matter (preferably corn gluten) is suspended or dissolved in a diluent (preferably water) so as to produce a liquid organic or organic-based fertiliser.

It has been observed that corn gluten which is available from standard commercial sources has sufficiently small particulate size so that when suspended in water without any further modification to its physical nature it is readily distributed through many usual forms of liquid dispersion systems. However, the vegetable matter in the fertiliser in this form readily settles out and thus requires a means of agitation to keep the matter in suspension so as to ensure approximately even distribution of the vegetable matter throughout the mixture. In addition, the vegetable matter would be likely to predispose water distribution systems having a relatively fine aperture to blockage.

A preferred embodiment of the present invention therefore is the solubilisation of the vegetable matter or reduction in its particulate size to such a point as to produce a

suspension sufficiently fine so as to allow the fertiliser to be easily distributed without recourse to continuous agitation during distribution. The vegetable matter will be composed principally of protein, with lesser amounts of carbohydrate, fats and fibre. Effective solubilisation of the vegetable matter, therefore, involves the solubilisation of as much of these four groups as possible.

The preferred protein containing vegetable matter in the present invention is corn (or maize) gluten. In addition to having the highest concentration of both protein and carotenoids of vegetable matters currently available in commercial quantities, corn gluten also has relatively low levels of fats (typical range 4-8%) and fibre (typical range 1.0-2.5%), the latter two chemical groups being chemicals which could be expected to be relatively difficult to solubilise.

Solubilisation of the vegetable matter, when desired, can be achieved in a number of ways including (i) physical breakage of molecular chains, (ii) enzymatic digestion of chemical bonds, and (iii) acid- or alkaline-hydrolysis.

Physical methods include such processes as passing the protein-containing vegetable matter through a fine-pore emulsification pump, ultra-sonication and micro-wave irradiation. The latter two methods, as well as the process of enzymatic digestion, are used generally when it is desired to produce an organic fertiliser which has either little or no added inorganic elements.

Thus, in one preferred form of the invention, particulate gluten is suspended in water, and passed through a fine-pore emulsifying pump so that the material is reduced to microparticulate form with very low settling characteristics.

The emulsification process can be aided by lowering the pH of the suspension by addition of acid prior to emulsification. This facilitates hydrolysis and reduces slightly the time required for effective emulsification. Generally, the pH is reduced to between 3.5 - 6.0 and following completion of the emulsification process, sufficient alkali is added to return the pH of the suspension to between 6.0 - 7.5. The preferred acid to be added to facilitate the hydrolysis is nitric acid, and the preferred alkali is potassium hydroxide. Additional salts may be added during the emulsification process, as desired to produce a balanced fertiliser. One or more known emulsifying agents may also be added to the protein containing vegetable matter before emulsification, to promote formation and retention of an emulsion. Examples of emulsifying agents are agar agar, alcohol ethoxylates, alcohol sulfates, alkanolamides, alkyl benzene sulfonates, alkyl naphthalene sulfonates, alkyl phenol ether sulfonates, alkyl phenol ethoxylates, amine oxides, , ethoxylated aliphatic amines, ethoxylated fatty acid amides, ethoxylated fatty acid esters, ethoxylated fatty acids, ethoxylated glucose fatty acid esters, ethoxylated quaternary ammonium salts, fatty acid amides, fatty acids, glucose fatty acid esters, glycerol esters, guar gum, gum arabic, gum tragacanth, hydroxylated lanolin, lecithin, locust bean gum, mono- and di-ester sulfosuccinates, phosphate esters, sorbitan ester

ethoxylates, sorbitan esters and sulfonates.

Another preferred form of the current invention is a fertiliser comprising an organic base but with added inorganic elements to provide a fertiliser containing a balanced mix of a wide range of essential plant nutrients. In this case, one method of solubilisation of the vegetable matter is by either acid-hydrolysis or alkali-hydrolysis, whereby the added acid or alkali serve the additional role of providing a source of one or more of the required added inorganic elements, as well as serving as a preservative by prevention of microbial contamination of the finished product through either a strongly acidic or strongly alkaline pH.

In still another preferred form of the current invention, protein containing vegetable matter is suspended in water, and hydrolysed by the addition of either a strong alkali or a strong acid. While the hydrolysis procedure can be effected at ambient temperature, the speed of hydrolysis can be increased by heating the mixture to temperatures up to 100°C. The mixture is allowed to react for 1-3 hours, and then is vigorously agitated to complete hydrolysis and thereby produce the organic component of the fertiliser.

The preferred protein containing vegetable matter used in the invention is corn (also called maize) gluten, being the residue from corn (or maize) following the extraction of cornflour and cornstarch. Such residue is high in vegetable protein, typically having a protein level between 60-68%, and high in carotenoids, typically having a carotenoid level between 200-500 mg/kg. Corn gluten in dry form may be utilised, or use may be made of the aqueous gluten mixture produced during the cornflour extraction process and before the gluten mixture is dried. In the latter case, the aqueous mixture is either used as is, or additional dried corn gluten may be added to bring the protein content to a desired level, before treatment with the alteration agent.

During hydrolysis of protein (either animal or vegetable) by adjustment of pH, it is observed that alkaline-hydrolysis produces a more viscous hydrolysate compared to acid-hydrolysis, requiring a greater degree of physical shearing force to effect complete solubilisation. Where the desired level of nitrogen from organic protein in the final product is relatively low (up to 3%), then hydrolysis of the vegetable matter preferably is effected by alkali hydrolysis since hydrolysis occurs quicker and without the need for exothermic heat compared to acid hydrolysis. However, with relatively higher organic nitrogen levels, alkaline hydrolysis produces a mixture of such viscosity as to make it difficult to mix; in these circumstances, acid hydrolysis is the preferred method of hydrolysis.

For the preparation of a fertiliser in the dry form, the protein containing vegetable matter, after treatment with an alteration agent, is optionally mixed with added minerals and/or other additives as exemplified above, the pH may be adjusted by the addition of an appropriate pH adjusting material, liquids are separated and the resultant mixture is

added to a carrier of ground rice hulls.

The fertiliser produced by each of the above procedures is in concentrated form and generally requires dilution before being applied to plant foliage and/or soil or other growing media. A fertiliser composition is prepared by mixing the concentrated fertiliser with agriculturally-acceptable carriers, diluents, and/or adjuvants and optionally suspending agents. Dilution preferably is effected with water, and known inorganic and known organic fertilisers may also be added to produce a fertiliser mixture.

A plant subsequently is fertilised by applying to the foliage of the plant or to the locus of the plant or to the soil or water containing seeds or other propagating organs thereof, an effective amount of the fertiliser or the fertiliser composition or the fertiliser mixture.

It will be appreciated that the following examples illustrate only some of the many forms of the fertiliser in accordance with the present invention. It will also be realised that quantities stated are, of necessity, approximate and illustrative only. Actual quantities of the components referred to in the Examples may be varied depending on the application to which it is proposed to put the fertiliser.

EXAMPLE 1

0.9 kg of potassium hydroxide is dissolved in 100 litres of water at ambient temperature. 18.4 kg of corn gluten (68% protein) is then added slowly and allowed to stand for 30 minutes. The mixture is then agitated vigorously with an emulsifying pump for approximately 15 minutes to effect hydrolysis. The following ingredients are then stirred into the hydrolysed mixture: 2.65 kg calcium nitrate; 8.53 kg potassium nitrate; 5.65 kg monoammonium phosphate; 9.16 kg urea; 3.03 kg magnesium sulphate; 600 gm ferric sulphate; 100 gm sodium borate; 45 gm zinc sulphate; 30 gm copper sulphate; 25 gm manganese sulphate; 6 gm sodium molybdate; 3 kg zeolite; 1 litre of phosphoric acid. A fragrance or perfume is then incorporated to improve the aesthetic appeal of the product.

The resulting product is a creamy viscous fluid having an N:P:K: value of 8.4: 2.0: 4.0 respectively, and an organic nitrogen level of 2%. The pH of the product is approximately 2.3, such low pH serving to inhibit microbial decomposition of the product during storage.

EXAMPLE 2

1 litre of nitric acid is added to 100 litres of boiling water. 30.8 kg of corn gluten (68% protein) is stirred slowly into the water and the mixture maintained at a temperature of approximately 100°C for 1 hour by which time hydrolysis normally is completed. The following ingredients are then stirred into the hydrolysed mixture: 2.5 kg calcium nitrate; 4.9 kg potassium nitrate; 3.8 kg monoammonium phosphate; 1.0 kg magnesium sulphate; 300 gm ferric sulphate; 50 gm sodium borate; 23 gm zinc sulphate;

20 gm copper sulphate; 13 gm manganese sulphate; 6 gm sodium molybdate; 3 kg zeolite.

The resulting product is a creamy, viscous fluid at a pH of 2.3, having an N:P:K value of 5.0: 1.2: 2.0 respectively, and an organic nitrogen level of 5%.

EXAMPLE 3

30.8 kg of corn gluten (68% protein) is added with stirring to 100 litres of warm water (30-35°C). 200 gm of the proteolytic enzyme, ficin, is added to the mixture which is then stirred slowly for 2 hours. The mixture then is vigorously agitated with an emulsifying pump for 15 minutes to effect complete hydrolysis. To preserve the product so as to prevent decomposition, an acid such as phosphoric acid is added in sufficient quantities to lower the pH to 2.5. Alternatively, a chemical preservative such as sodium benzoate may be included.

Following hydrolysis of the vegetable matter as described in Examples 1 to 3, the fertiliser can be used directly (after dilution) as a fertiliser, or, more preferably, have a variety of inorganic elements added (as described in Examples 1 and 2) in order to produce a fertiliser having a balance of inorganic and organic elements.

EXAMPLE 4
Liquid form fertiliser

An alternative liquid form fertiliser formulation comprising emulsified corn gluten is as follows:

	g / L
corn gluten	350.00
ammonium nitrate	35.00
potassium nitrate	60.00
potassium dihydrogen phosphate	45.00
ferric sulphate ($7H_2O$)	2.50
manganese sulphate ($5H_2O$)	0.25
copper sulphate ($5H_2O$)	0.20
zinc sulphate ($7H_2O$)	0.22
sodium borate ($10H_2O$)	0.25
sodium molybdate ($7H_2O$)	0.06
zeolite	3.00
sodium benzoate	0.50

The formulation of Example 4 may optionally also contain salts of other ions, such as magnesium and/or calcium.

To prepare this liquid form fertiliser, the ingredients, weighed in quantities as required for the volume of fertiliser to be produced, are slowly added to the required quantity of water in a mixing tank which is being agitated with a propeller agitator, until

all the ingredients are in suspension or dissolved. An emulsifying pump or homogeniser of a size appropriate for the volume of fertiliser to be prepared is then lowered into the tank and emulsification of the suspension is commenced. The time required to achieve satisfactory emulsification will vary depending on the volume of material, temperature and size of the emulsification equipment. However, typically it has been found that to emulsify 1000 litres satisfactorily at 22°C will require six hours of constant emulsification.

It is to be recognised that while the Examples represent products containing a range of essential elements for plants, the invention can equally be applied for the production of fertilisers with additional elements, different ratios of elements or lacking one or more essential elements.

The fertiliser produced by each of the above examples is in concentrated form and requires dilution before it can be applied to plant foliage and/or soil or other growing media. Dilution is preferably effected with water and the recommended dilution rate is one part of fertiliser to 100 - 250 parts of water. The preferred dilution rate for the formulation of Example 4 is 1 part of fertiliser to 100 parts of water. It is found that the optimal rate of application to growing media or foliage is 1 litre of diluted fertiliser per one square metre, repeated at fortnightly intervals.

EXAMPLE 5

Fertiliser comparison trial

Ten different fertilisers, including a fertiliser in accordance with the present invention herein referred to as "Organic Gold", were applied weekly to eight commonly grown ornamental plant species.

The fertiliser "Organic Gold" had a composition as described in Example 4 above, and was prepared as follows:

0.5 L of nitric acid was added to 100 L water at room temperature. 35 kg of corn gluten was added and emulsified vigorously with an emulsifying pump for 30 minutes until a smooth consistency was achieved. 200 g potassium hydroxide was then added to return the pH to 6.5 - 7.0. The inorganic salts shown in Example 4 were then added in the amounts shown and emulsification was continued for a further 10 minutes. Sodium benzoate (0.5 g/L) was added as preservative, followed by guar gum (0.2%) as a thixotropic agent.

Application rates of the fertilisers were adjusted so that all plants received the same amount of nitrogen with each treatment. Shoot dry weight and overall quality were compared. Significant differences were found in the response to various fertilisers by different plant species. Consistently good results were obtained from "Organic Gold".

The fertilisers compared to "Organic Gold" were four well-known commercially available organic fertilisers, four well-known commercially available inorganic liquid

fertilisers, pelleted poultry manure, and a water control. some of the commercially available fertilisers against which "Organic Gold" was compared have identical amounts of nitrogen and other essential elements, compared to "Organic Gold".

Eight plant species were chosen: four common greenhouse grown plants and four common outdoor plants. The greenhouse plants were: *Adiantum fragrans* (Maidenhair fern), *Aphelandra squarrosa* (Zebra plant), *Gerbera* "Festival" (Transvaal daisy) and *Saintpaulia ionantha* (African violet). The outdoor plants were: *Lavendula dentata* (Lavender), *Gardenia augusta* "Florida", *Rosa* "Flower Carpet", and *Hebe* sp.

The trial was laid out in randomised block format, one block per plant species, comprising five replicates of eleven treatments. At the start of the trial, the young plants in each block were chosen for uniformity, then randomly placed within each row. Each block of 55 pots was grown in the same environment as, and alongside, a commercial crop of the same species. The commercial crops were potted into media containing slow release fertiliser, while the trial pots were potted into media without slow release fertiliser.

Each treatment was applied weekly. The soluble fertilisers were diluted to provide 0.05 g of nitrogen at each application. The pelleted product was measured by weight to provide 0.05 g of nitrogen at each application. All dosages were calculated from information provided on the respective labels.

The trial continued until the equivalent commercial crop was ready for sale.

At the end of the trial period the plants were assessed as follows:

Each was examined for overall quality, by a skilled grower unaware of the treatment codes, and assigned a grade on a scale from 0 to 5.

Plant heights were recorded for *Adiantum*, *Aphelandra*, *Gerbera*, *Hebe*, *Lavendula*, and *Saintpaulia*.

Shoot dry weight was recorded for each replicate.

Treatment means for quality and for dry weight were compared and the differences tested for significance at the 90% confidence level.

Results

Dry Weight

Shoot dry weights of the test plants at the end of the trial are recorded in Table 1 (for the organic fertilisers compared to "Organic Gold") and Table 2 (for the inorganic fertilisers compared to "Organic Gold") below.

As is seen from Tables 1 and 2, three fertilisers caused the greatest increase in shoot dry weight in 6 out of the 8 crops tested (treatments designated 'a'). "Organic Gold" was one of these three fertilisers. No fertiliser caused the greatest increase in more than 6 out of the 8 plants in this test.

The three fertilisers which caused the greatest increase in shoot dry weight did not

perform equally well on the same crops. The two fertilisers other than "Organic Gold" which produced the greatest increase in shoot dry weight, fertilisers "G" and "H", are both inorganic formulations.

Table 3 sets out the mean plant dry weight and total flower dry weight observed with the African Violets. "Organic Gold" produced significantly greater shoot dry weight, mean plant dry weight and total flower dry weight than any other fertiliser.

Overall Quality (see results in Tables 4 and 5)

For each crop, several fertilisers rated well but "Organic Gold" was the only fertiliser to be placed in the top significance level for all 8 crops.

EXAMPLE 6

Trial with African Violets and Gerberas

A larger scale trial, using a fertiliser whose composition and method of preparation were as described in Example 4, was conducted on African Violets and Gerberas. In this trial, the fertiliser of the invention and the commercially available fertilisers referred to in Example 5 were applied to African Violets and Gerberas and the shoot dry weights were measured at the end of the trial. Table 6 below sets out, for each fertiliser treatment and for a control in which only water was applied, the differences in grams between the mean shoot dry weight and the overall mean shoot dry weight averaged over all the treatments. For each plant, the fertiliser of the invention gave the greatest mean shoot dry weight gain of all of the fertilisers tested.

INDUSTRIAL APPLICABILITY

A fertiliser of the invention can be readily utilised to provide the nutrient requirements of plants.

Table 1

"Organic Gold" compared with major brand organic fertilisers

	Maidenhair fern	Gerbera	Hebe	Rose	African Violet	Aphelandra	Lavender	Gardenia
"Organic Gold"	7.60 a	11.30 a	6.07 b,c	29.40 a	4.38 a	9.14 b,c	12.30 a,b,c	10.50 a,b,c
Poultry Manure	4.26 b,c	6.10 c	2.89 d	16.70 c,d	3.32 b	5.36 d	6.10 d	6.80 d
Fertiliser A	7.96 a	7.80 b,c	7.29 a,b	28.10 a,b	2.76 b,c	9.93 b,c	11.20 a,b,c	10.90 a,b
Fertiliser B	7.42 a	10.90 a,b	6.79 a,b,c	29.10 a	2.86 b,c	10.05 b,c	13.70 a,b	9.00 b,c
Fertiliser C	8.70 a	10.70 a,b	6.28 b,c	32.90 a	3.50 b	10.41 b,c	14.30 a	11.50 a
Fertiliser D	2.69 b	8.10 b,c	5.19 c	21.70 b,c	2.42 c	7.90 c,d	12.50 a,b,c	9.50 b,c
Water only	0.74 c	0.70 d	1.07 d	12.10 d	1.24 d	1.86 e	3.50 d	6.20 d

Table 2

"Organic Gold" compared with major brand, soluble inorganic fertilisers

	Maidenhair fern	Gerbera	Hebe	Rose	African Violet	Aphelandra	Lavender	Gardenia
"Organic Gold"	7.60 a	11.30 a	6.07 b,c	29.40 a	4.38 a	9.14 b,c	12.30 a,b,c	10.50 a,b,c
Fertiliser E	7.46 a	10.50 a,b	5.07 c	27.70 a,b	3.34 b	11.51 a,b	10.90 b,c	9.00 b,c
Fertiliser F	7.74 a	9.00 a,b,c	8.36 a	29.60 a	3.12 b,c	10.07 b,c	11.10 b,c	10.90 a,b
Fertiliser G	7.80 a	10.30 a,b	5.23 c	31.10 a	3.46 b	10.97 a,b	11.50 a,b,c	11.70 a
Fertiliser H	8.60 a	10.40 a,b	6.81 a,b,c	31.90 a	2.20 c	13.60 a	10.20 c	10.80 a,b
Water only	0.74 c	0.70 d	1.07 d	12.10 d	1.24 d	1.86 e	3.50 d	6.20 d

Treatments with the same letter of the alphabet show no significant difference at the 90% confidence level.

Table 3

Results for African Violets

Fertiliser	Mean plant dry weight (g)	Total flower dry weight (g)
Water only	1.24	0.60
Fertiliser H	2.20	0.75
Fertiliser G	3.46	1.98
Fertiliser C	3.50	2.45
Fertiliser F	3.12	0.33
Fertiliser E	3.34	2.18
Poultry Manure	3.32	3.43
Fertiliser D	2.42	2.16
Fertiliser B	2.86	1.25
Fertiliser A	2.76	1.86
"Organic Gold"	4.38	4.13

Table 4

"Organic Gold" Compared with major brand organic fertilisers

	Maidenhair fern	Gerbera	Hebe	Rose	African Violet	Aphelandra	Lavender	Gardenia
"Organic Gold"	4.40 a,b	3.25 a,b	3.40 a	3.10 a	3.80 a,b	3.40 a,b	3.20 a,b	3.00 a,b
Poultry Manure	2.80 c	2.40 c,d	1.60 d	1.60 b	3.40 a,b	2.00 c	2.00 c	1.50 c,d
Fertiliser A	4.40 a,b	2.80 b,c	3.20 a,b	2.90 a	3.00 b	3.80 a,b	3.20 a,b	3.10 a
Fertiliser B	4.40 a,b	1.60 d,e	3.40 a	3.10 a	3.60 a,b	3.40 a,b	3.40 a,b	2.60 a,b
Fertiliser C	5.00 a	2.40 c,d	2.20 c,d	3.40 a	3.20 a,b	3.80 a,b	3.60 a	3.30 a
Fertiliser D	2.40 c	3.60 a,b	3.20 a,b	2.70 a	2.00 c,d	3.20 b	3.00 a,b	2.80 a,b
Water only	1.00 d	1.00 e	0.60 e	0.90 b	1.20 d	1.00 d	1.40 c	0.80 d

Table 5

"Organic Gold" compared with major brand, soluble inorganic fertilisers

	Maidenhair fern	Gerbera	Hebe	Rose	African Violet	Aphelandra	Lavender	Gardenia
"Organic Gold"	4.40 a,b	3.25 a,b	3.40 a	3.10 a	3.80 a,b	3.40 a,b	3.20 a,b	3.00 a,b
Fertiliser E	3.80 b,c	2.40 c,d	3.00 a,b,c	3.10 a	4.00 a	3.80 a,b	3.00 a,b	2.30 b,c
Fertiliser F	2.40 c	3.80 a	3.20 a,b	2.90 a	2.80 b,c	3.40 a,b	2.80 b	2.90 a,b
Fertiliser G	4.20 a,b	2.20 c,d	2.40 b,c,d	3.30 a	3.20 a,b	4.20 a	3.20 a,b	3.30 a
Fertiliser H	4.00 a,b	2.40 c,d	3.40 a	3.10 a	2.60 b,c	3.80 a,b	3.00 a,b	3.10 a
Water only	1.00 d	1.00 e	0.60 e	0.90 b	1.20 d	1.00 d	1.40 c	0.80 d

Treatments with the same letter of the alphabet show no significant difference at the 90% confidence level.

Table 6

Deviation from overall mean shoot dry weight (g)

Fertiliser	African violets	Gerberas
"Organic Gold"	1.41	2.57
Fertiliser A	- 0.20	- 0.88
Fertiliser B	- 0.09	2.19
Fertiliser C	0.54	1.97
Fertiliser D	- 0.54	- 0.60
Fertiliser E	0.37	1.75
Fertiliser F	0.14	0.27
Fertiliser G	0.51	1.53
Fertiliser H	- 0.76	1.64
Poultry manure	0.37	- 2.63
Water only	- 1.72	- 7.98

CLAIMS

1. A plant fertiliser comprising at least one fertiliser component and a plant growth enhancing amount of at least one carotenoid.

2. A fertiliser according to claim 1, wherein said fertiliser component comprises altered protein containing vegetable matter, as herein defined, having a plant growth enhancing amount of at least one carotenoid.

3. A fertiliser according to claim 1, wherein said fertiliser component is selected from the group consisting of a known inorganic fertiliser component and a known organic fertiliser component.

4. A fertiliser composition comprising:

at least one fertiliser according to claim 1; and

an agriculturally acceptable carrier, diluent, and/or adjuvant and optionally a suspending agent.

5. A fertiliser composition according to claim 4, wherein said fertiliser component comprises altered protein containing vegetable matter, as herein defined, having a plant growth enhancing amount of at least one carotenoid.

6. A fertiliser mixture, comprising a fertiliser according to claim 1 or a fertiliser composition according to claim 4 in combination with at least one component selected from the group consisting of a known inorganic fertiliser component and a known organic fertiliser component, said fertiliser mixture comprising altered protein containing vegetable matter, as herein defined, having a plant growth enhancing amount of at least one carotenoid.

7. A fertiliser according to claim 2, a fertiliser composition according to claim 5 or a fertiliser mixture according to claim 6, wherein said protein containing vegetable matter is cereal-derived.

8. The fertiliser, fertiliser composition or fertiliser mixture of claim 7, wherein said protein containing vegetable matter is gluten.

9. The fertiliser, fertiliser composition or fertiliser mixture of claim 8, wherein said gluten is corn gluten.

10. The fertiliser, fertiliser composition or fertiliser mixture of claim 7 wherein said altered protein containing vegetable matter is corn gluten emulsified in water.

11. A process for preparing a plant fertiliser, comprising dissolving or suspending in water at least one fertiliser component and a plant growth enhancing amount of at least one carotenoid.

12. A process according to claim 11, wherein said fertiliser component is selected from the group consisting of a known inorganic fertiliser and a known organic fertiliser.

13. A process according to claim 11, comprising:

altering at least one fertiliser component comprising protein containing vegetable matter, as herein defined, by treating said component with an alteration agent to form the

fertiliser, wherein said protein containing vegetable matter comprises at least one carotenoid and wherein said fertiliser comprises altered protein containing vegetable matter, as herein defined, and a plant growth enhancing amount of at least one carotenoid.

14. A process according to claim 13, wherein said protein containing vegetable matter is treated with said alteration agent under conditions such that said altered protein containing vegetable matter is at least partially water soluble or forms an emulsion with water.

15. A process according to claim 13, wherein said alteration agent comprises the application of shearing forces.

16. A process according to claim 15, wherein said protein containing vegetable matter is corn gluten.

17. A fertiliser whenever prepared by a process according to claim 11.

18. A method of fertilising a plant comprising applying to a location selected from the group consisting of the foliage of said plant, the locus of said plant, soil containing seeds or other propagating organs of said plant, and water containing seeds or other propagating organs of said plant, an effective amount of an agent selected from the group consisting of a fertiliser according to claim 1 or claim 17, a fertiliser composition according to claim 4, and a fertiliser mixture according to claim 6.

19. A method according to claim 18, wherein said fertiliser, fertiliser composition or fertiliser mixture comprises altered protein containing vegetable matter, as herein defined, having a plant growth enhancing amount of at least one carotenoid.

20. A method according to claim 18 wherein said plant is selected from the group consisting of a flowering plant, a flowering shrub and a leafy vegetable.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 94/00703

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.^{6} C05F 11/10, C05G 3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C05 - KEYWORDS: CAROTEN:, XANTHO:, :XANTHIN, LUTEIN, LYCOP:, :BIXIN, CROCETIN, CROCIN, LYCOPHYLL, GLUTEN

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)
DIALOG - CAROTEN:, XANTHO:, :XANTIN, LUTEIN, LYCOP:, :BIXIN, CROCETIN, CROCIN, LYCOPHYLL, GLUTEN

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	US,A, 4961774 (BROCHIER, J.) 9 October 1990 (09.10.90). Column 2 lines 53-57 and column 3 line 62 to column 4 line 21	1-6, 11, 12, 17-20
X	JP,A, 52-081263 (FURUHASHI K.K.) 7 July 1977 (07.07.77). Also Derwent WPAT Online Abstract Accession No. 77-59949Y/34, JP,A, 52-081263 (FURUHASHI K.K.) 7 July 1977 (07.07.77)	1, 4, 11, 12, 19, 20

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 February 1995 (28.02.95)	8 Mar 1995 (08.03.95)

Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	S.R. IDRUS Telephone No. (06) 2832536

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X	JP,A, 61-141692 (DAI-ICHI SEIMO K.K.) 28 June 1986 (28.06.86). Also Derwent WPAT online Abstract Accession No. 86-208837/32, JP,A, 61-141692 (DAI-ICHI SEIMO K.K.) 28 June 1986 (28.06.86)	1, 4, 11, 12, 19, 20
X	AU,A, 35139/93 (HARMONY PRODUCTS INC.) 16 September 1993 (16.09.93) Page 3 lines 8-24, page 6 lines 18-22, page 9 line 36 - page 10 line 3 and claims 2+19	1-20
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X	US,A, 4764199 (PRATT, G. et al) 16 August 1988 (16.08.88) Column 2 lines 17-43	1, 2, 4, 5, 7-9, 11, 13-19
X,P	JP,A, 06-191977 (NAKAMURA SANGYO K.K.) 12 July 1994 (12.07.94). Also Derwent WPAT Online Abstract Accession No. 94-260346/32	1-6, 11-14, 17-20
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X,P	JP,A, 06-217621 (TAKEHIKO AKAIWA) 9 August 1994 (09.08.94). Also Derwent WPAT Online Abstract Accession No. 94-289929/36 (AKAIWA, T.) 9 August 1994 (09.08.94)	1, 3, 4, 11, 12, 17-20

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	4961774	AT	58453	DE	3675740	EP	223624
		FR	2587587	US	4961774		
AU	35139/93	AU	53139/93	AU	654795	CA	2091045
		EP	560626	JP	6009289	US	5240490
US	4990173	CA	1315116	DE	3879754	DK	2483/88
		EP	290236	ES	2054803	JP	63297289
		US	4990173				

END OF ANNEX